

Student teachers' attitudes concerning understanding the nature of science in Turkey

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Nature of science is defined as one of the directions of scientific literacy. The main aim of this study was to investigate both secondary school social and science branch post-graduate (non-thesis master) teacher candidates attitudes about the Nature of Science (NOS) and compare their attitudes towards NOS. A 12-item Likert type scale for teacher candidates was used, based on responses of 207 participants. The results indicated that teachers had low positive attitudes towards NOS, but found some significant understanding differences against scaled items between social and science teacher candidates. There was no relationship between the attitudes to the NOS, and the scientific disciplines.

Nature of science, teacher attitudes, scientific literacy, secondary school teachers

INTRODUCTION

Over the last three decades, a number of researchers used a wide range of probes and instruments to examine what teachers understood about the nature of science (Hamrich, 1997; Nott and Wellington, 1998). We do not have the space here to summarise them, but we can say that some have involved written tests and questionnaires, some have involved lesson observation, others have been based on interviews with teachers, and others have involved a mixture of classroom observations and interviews.

Lederman and Zeidler (1987) described the Nature of Science (NOS) as an individual's values inherent to his or her development of scientific knowledge. The NOS is about how science proceeds, how the scientific community decides what to accept and reject, and how much faith there is in a large body of scientific knowledge and beliefs that are continuously developing (Hamrich, 1997). Recently, the NOS is defined as the epistemological underpinnings of science, which includes empirically-based, tentative, subjective, creative, unified, and cultural and socially embedded characteristics. Individuals who understand the NOS can recognise the functions of their subject matter and distinguish the differences among observations, inferences, scientific facts, laws, and theories (Gess-Newsome, 2002).

Philosophers of science, historians of science, sociologists of science, and science educators are quick to disagree on a particular definition for NOS. However, at any given in time and at a certain level of generality, there is agreement about some important aspects of NOS among philosophers, historians, sociologists, and educators (Abd-El-Khalic, 2001).

In the past several decades, the goals of most science programs have included developing an adequate understanding of the NOS and understanding science as a way of knowing. Scientific literacy involves understanding not only scientific knowledge, but also understanding the NOS (Tobin and McRobbie, 1997). Teachers translate the written curriculum into a form required for classroom application and decide what, how and why to learn. Despite the pervasive and critical role of curricula, evidence is clear and substantial that teachers are the most influential factor in educational change (McComas and Almazroa, 1988). Thus science teachers need to understand the NOS in order to improve the scientific literacy of their students (Abd-El-Khalic, 2001).

Turkey is currently undergoing a process of educational reform in teacher training as well as primary and secondary education. In 1992, the two-year classroom teacher training program became a four-year program, and teaching became a university graduate profession. In 1997, the Basic Education Law was implemented, increasing the length of compulsory primary schooling from 5 to 8 years. A system of faculty-school partnerships was set up in 1998 by The Council of Higher Education (YOK) and the Ministry of National Education. To assist these developments, school teachers began to be more involved with student teachers' school experience and teaching practice activities. In the new teacher training system, science graduates from different faculties except the faculty of education graduates (with a degree in physics, chemistry, biology, history, philosophy) have a 2 or 3-semester postgraduate university education centred primarily around their field of study. In these degree courses, graduate students take a brief post-graduate pedagogical course and a short period of teaching practice in a secondary education centre (YOK, 1998 p.18).

METHOD

Instrumentation

In order to assess teacher understanding of the NOS, a modified form of an existing scale (Rutlage and Warden, 2000) was used. A modified form of this scale containing 12 items was used in the present study. Scoring for the items was performed by Likert scaling of responses. Answers to items indicating a low acceptance received a score of 1, while answers indicating a high acceptance received a score of 5.

Participants

The population of interest in this study consists of 207 post-graduate student teachers; they have graduated in the 2002-2003 academic years from either social or natural science post-graduate for Secondary School Education program. They had their graduate education in various disciplines in 37 different universities in Turkey.

Procedures

The questionnaires were filled by the participants. The cover note also served to assure them that the research was not focused on any one individual and that their responses would be strictly confidential and anonymous.

We analysed scaled items using descriptive statistics (counts, means, and percentages). In addition to computing descriptive statistics, we performed an analysis (ANOVA) for items to determine the differences and explore relationships ($p < 0.05$) between the variables and respondent groups. In terms of reliability in tested populations, a Cronbach alpha was calculated for the items ($\alpha = 0.71$). The SPSS for Windows (ver.10) statistical software package was used in all analyses.

RESULTS

Among the student teachers generally a low level of understanding of the NOS was obtained through Likert-scaling of teacher responses, presented in Table 1. Characteristics of science particularly was not well understood including the independence of scientific knowledge from religious affirmation (Item 6), direct observation (item 8), and the limits of science (Item 12). The characteristics of science best understood by the student teachers were the goals of science (Item 1), scientific theories (Items 2 and 11), scientific experiments (Items 5 and 7), and the inability of science to address ultimate causation (Item 9), which were correctly answered as a mean by 80 per cent of the both social and natural science student teachers.

Table 1. Teacher responses to scale items pertaining to the understanding of the NOS

		#	N	Totally disagree %	Disagree %	Undecided %	Agree %	Totally agree %	Mean
1	The goal of science is the improvement of man's quality of life.	NS	108	8.3	6.5	0.9	26.0	58.3	4.13
		SS	99	5.1	11.1	1.0	39.0	43.4	4.05
2	A theory has been corroborated by many scientific ideas.	NS	108	6.5	4.6	5.6	44.0	38.9	3.99
		SS	98	7.1	7.1	4.1	51.0	30.6	3.91
3	Scientist must be accepting of all findings of their fellow researchers.	NS	108	28.7	36.1	7.4	19.0	9.3	2.44
		SS	96	22.9	46.9	12.0	18.0	1.0	2.27
4	If an experiment yields results which are contradictory to one's hypothesis, one should find other ways to corroborate the hypothesis.	NS	108	10.2	15.7	14.0	41.0	19.4	3.43
		SS	98	12.2	12.2	16.0	40.0	19.4	3.41
5	Scientific experiments must be repeatedly performed to be considered valid.	NS	108	12.0	8.3	8.3	36.0	35.2	3.74
		SS	98	3.1	4.1	12.0	40.0	40.8	4.13*
6	Any scientific finding that contradicts religious doctrine should be discarded.	NS	108	29.4	25.7	12.0	17.0	15.6	2.8
		SS	96	16.7	29.2	27.0	19.0	8.2	2.73
7	A hypothesis must be capable of being tested in order for it to be in the realm of science.	NS	109	11.1	10.2	9.3	37.0	32.4	3.69
		SS	97	3.1	4.1	7.2	47.0	38.1	4.13**
8	To make any scientific determinations about historic occurrences in nature, there must be direct human observation.	NS	104	12.5	27.9	22.0	30.0	7.7	2.92
		SS	98	6.1	21.4	19.0	44.0	9.2	3.28*
9	As a result of scientific methods, definite conclusions can be made to the absolute and ultimate cause behind an event.	NS	106	8.5	5.7	1.9	44.0	39.6	3.99
		SS	98	5.1	4.1	3.1	53.0	34.7	4.08
10	Science is well-prepared to investigate the validity of miracles.	NS	107	14.0	43.9	13.0	23.0	5.6	2.64
		SS	96	11.5	41.7	10.0	33.0	3.1	2.74
11	A hypothesis which has been validated by an experiment is elevated to the level of theory.	NS	107	9.3	8.4	11.0	54.0	16.8	3.59
		SS	98	3.1	12.2	6.1	57.0	21.4	3.83
12	A fact in science is a truth which can never be changed.	NS	109	22.9	36.7	10.0	20.0	10.1	2.61
		SS	99	9.1	32.3	14.0	31.0	13.1	3.07**

NS; natural science. SS; social science. * $p < 0.05$; ** $p < 0.01$ in comparing NS and SS graduates (ANOVA).

Significant relationships were found between responses (Item 5, 7, 8, and 12) comparing natural and social science student teachers. According to results obtained from present investigations, it is observed that most of the student teachers possessed inadequate viewpoints on the NOS. The

teachers' academic backgrounds were not significantly related to their understanding of concepts of science (Table 1). For all disciplinary fields, (i.e. philosophy, biology, physics) a lack of understanding of the nature of scientific knowledge was detected. In the Items 5, 7, 8 and 12 statistically meaningful results were found in favour of social science graduates (Table 2). In other scaled items, most of the teachers held traditional (positivist) attitudes.

Table 2. ANOVA of the significant teacher responses to scaled items

Item		Sum of Squares	Df	Mean square	F
5		7.09	1	7.09	5.05*
	within group	286.51	205	1.40	
7		9.87	1	9.87	7.37**
	within group	272.17	203	1.34	
8		6.64	1	6.64	5.12*
	within group	259.38	201	1.30	
12		12.60	1	12.60	7.70**
	within group	337.09	207	1.64	

* $p < 0.05$; ** $p < 0.01$

This result might indicate the beneficial effect of some courses such as philosophy and sociology taken during the graduate education of the social science teacher students. It was not a surprise that teachers' views of the NOS did not correlate with their previous academic history. As Lederman (1992) pointed out, very few science teachers had formally studied the NOS at a school, a college or a university. There are a number of studies confirming students' misconceptions concerning the NOS. The researchers found that they confused science with technology, and they were only superficially aware of the private and public side of science and the effect that values had on scientific knowledge (McComas and Almazroa, 1988).

DISCUSSION

A dynamic understanding of science requires significant background in the social studies of science. However, present undergraduate science and science teacher education curricula in Turkey do not emphasise the philosophical background of science content. One of the causes of the failure of many science courses and programs lies in the ambiguity of their philosophical standpoints, and their confused conceptions about the NOS. Philosophy of science is little taught in science teacher education programs (Mellado, 1997). This study showed that teachers in the sample held traditional (positivist) views about the nature of science.

Static knowledge is necessary for science teachers, but it is insufficient for them to learn how to teach. Teachers' understandings of the NOS are rooted as much in their practice as in their formal education (Nott and Wellington, 1998). Furthermore, teachers' understanding of the NOS can influence their approach to science teaching and even their teaching behaviours (Eichinger et al., 1997).

In recent years, research into teachers' conceptions of the NOS has become a priority theme of educational research. In order to improve conceptions of the NOS, some studies primarily focused on curricular improvements while the others focused on teachers. There is a general agreement that the NOS has for many years been absent both from science curricula and from teacher education.

The evidence suggests that teachers' beliefs concerning science affect not only the lessons on NOS but also the curricular material dealing with the nature of scientific knowledge. When the prospective teachers begin at university, they carry with them academic knowledge, certain values, beliefs and attitudes about science, teaching and so forth (Mellado, 1997). A person's beliefs about the NOS are coherent with the view of science as it is embedded within the enacted curriculum from which they learn (Tobin and McRobbie, 1997).

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